

What is claimed is:

1. An aqueous acidic solution that provides a black chromate conversion coating on zinc and zinc alloys comprising:

trivalent chromium ions in a concentration of about 0.02M to about 0.2M;

phosphorous anions;

anions selected from the group of sulfate ions, nitrate ions, and combinations thereof;

at least one transition metal or metalloid selected from groups III, IVa, Va, or VIII; and

an organic chelate selected from the group consisting of carboxylic acids, polycarboxylic acids, and combinations thereof.

2. The solution of claim 1, wherein the concentration of trivalent chromium ions is from about 0.03M to about 0.07M.

3. The solution of claim 1, wherein the phosphorous anions are present in a concentration of from about 0.05M to about 0.75M.

4. The solution of claim 1, wherein the phosphorous anions are provided by phosphorous acids or salts thereof selected from the group consisting of phosphoric acid, mono-sodium phosphate, mono-ammonium phosphate and mixtures thereof.

5. The solution of claim 1, wherein the solution comprises a transition metal selected from the group consisting of iron, cobalt, nickel, copper and combinations thereof.

6. The solution of claim 5, wherein the transition metal is present at a concentration of from about 0.005M to about 0.5M.

7. The solution of claim 1, wherein the organic chelate is present in a concentration of from about 0.02M to about 0.3M.

8. The solution of claim 1, wherein the organic chelate is a carboxylic acid or polycarboxylic acid selected from the group consisting of citric acid, tartaric acid, malic acid, glyceric acid, lactic acid, glycolic acid, malonic acid, succinic acid, maleic acid, oxalic acid, flutaric acid, and combinations thereof.

9. The solution of claim 1, wherein the solution has a pH of about 0.5 to about 3.5.

10. A method for forming a black trivalent chromium chromate conversion coating on zinc or zinc alloys comprising:

forming a zinc or zinc alloy coating on a substrate;

immersing the zinc or zinc alloy coating in a aqueous acidic chromate solution having pH of about 0.5 to about 3.5; trivalent chromium ions in a concentration of about 0.02M to about 0.2M; phosphorous anions; anions selected from the group of sulfate ions, nitrate ions, and combinations thereof; at least one transition metal or metalloid selected from groups III, IVa, Va; or VIII; and an organic chelate selected from the group consisting of carboxylic acids, polycarboxylic acids, and combinations thereof; and

drying the zinc or zinc alloy coating to which the black trivalent chromium chromate conversion coating has been applied.

11. The method according to claim 10, wherein the concentration of the trivalent chromium ions is from about 0.03M to about 0.07M.

12. The method according to claim 10, wherein the phosphorous antoms are present in a concentration of from about 0.05M to about 0.75M.

13. The method according to claim 10, wherein the chromate solution comprises a transition metal selected from the group consisting of iron, cobalt, nickel, copper and combinations thereof.

14. The method according to claim 13, wherein the transition metal is present at a concentration of from about 0.005M to about 0.5M.

15. The method according to claim 10, wherein the organic chelate is present in a concentration of from about 0.02M to about 0.3M.

16. The method according to claim 10, wherein the chromate solution has a pH of about 1.2 to about 2.5.

17. The method according to claim 10, wherein the chromate solution has a pH of about 1.5 to about 2.0.

18. The method according to claim 10, wherein the temperature of the chromate solution is from about 18°C to about 60°C.

19. An acidic chromate solution for forming a blank chromate conversion coating comprising:

trivalent chromium ions in a concentration of from about 0.02M to about 0.2M;

phosphorous anions in a concentration of from about 0.05M to about 0.75M;

anions selected from the group consisting of sulfate ions, nitrate ions, and combinations thereof;

a metal selected from the group consisting of iron, cobalt, nickel, copper and combinations thereof; and

an organic chelate selected from the group consisting of carboxylic acids and polycarboxylic acids, the organic chelate being present in an amount of from about 0.02M to about 0.3M.

20. An aqueous acidic solution that provides a black chromate conversion coating on zinc and zinc alloys comprising:

trivalent chromium ions in a concentration of about 0.02M to about 0.2M;

phosphorous anions;

anions selected from the group of sulfate ions, nitrate ions, and combinations thereof; and

at least one transition metal or metalloid selected from groups III, IVa, Va, or VIII.